NOTES ON THE BIONOMICS OF ZONOSEMATA VITTIGERA (COQUILLETT), A FRUIT FLY ON SOLANUM

(Diptera: Tephritidae)

MONT A. CAZIER
University of California, Berkeley

The genus *Zonosemata* is represented in the North American fauna by two species. *Zonosemata electa* (Say), the pepper maggot, because of its economic importance has been studied rather extensively and its host plants and distribution are rather well-known. *Zonosemata vittigera* (Coquillett) has been collected on a number of plants—alfalfa, cotton, sunflower, orange, peach and quince (Foote, 1960: 114), but its only authenticated natural food plant is *Solanum elaeagnifolium* Cavanilles (Foote, 1960). It is possible that *Z. vittigera* may eventually be found in cultivated plants and information on its biology and parasites may ultimately be of economic importance.

Solanum elaeagnifolium, also known as white or silver horsenettle, bull-nettle and trompillo is widely distributed throughout much of southwestern North America occurring from Kansas, Colorado and Texas, west into California and south to tropical America. In Arizona it occurs throughout the arid portions of the state from 1,000 to 5,500 feet (Kearney and Peebles, 1951) where it is most commonly found around sink holes, tanks, along roadsides and fields usually where the ground has been disturbed. It apparently prefers sandy soil and is a conspicuous member of the desert flora although it is on occasion a "weed" pest of all kinds of cultivated crops and is of little or no value as forage. It reproduces either from the seeds or from creeping rootstalks, is silver in color and covered with spines. The blooming period is long, extending from May to October, and seeds may be found during most of this period although more abundantly from June to September. The flowers are conspicuous and vary from deep violet to blue. The round fruit, which ranges from 1/3 - 1/2 inch in diameter, are mottled green when young, yellow upon maturity and often remain on the plants throughout the winter months. Those seeds that are dark or black are the result of the infestation of *Zonosemata vittigera* larvae.

The unripe fruit of this plant is reputed to be poisonous because of the presence of an alkaloid, solanin, but the Pima Indians use the crushed berries in making cheese (Kearney and Peebles,

1951) and a number of insect species, including *Z. vittigera,* thrive on the berries, both ripe and unripe. A protein digesting enzyme resembling papain has also been found in the plant.

The adults of this fly were observed mating on the leaves and stems of *Solanum elaeagnifolium* in June and July of 1960 at a locality two miles northeast of Portal, Arizona, in an earthen tank. In July many of the green seeds showed oviposition punctures and had started to turn black, thus indicating that mating and oviposition had taken place earlier, probably in late May or early June. Females (Fig. 1) were observed ovipositing in the green or slightly yellow seeds during July and August of 1960 but had been laying earlier, probably in June, and fresh oviposition punctures were in evidence in early October.

The eggs are laid in the green pulpy material beneath the skin of the green or maturing fruit. When the ovipositor is withdrawn a small bubble of liquid exudes from the skin opening and is the only indication of infestation until the egg hatches and the larva begins to feed. As feeding begins the area around the puncture turns dark (Fig. 2) and becomes progressively larger as the larva continues to feed. Fruits with as many as nine oviposition punctures were noted but no more than three maturing larvae were ever found inside, the usual number being one larva per fruit. Thus, there is usually only one emergence hole in each fruit, but two are found occasionally. It would appear that although multiple oviposition occurs as a rule in the fruit, the larvae kill each other or succumb from lack of food until usually only one remains.

Although the larvae (Fig. 3) begin feeding beneath the skin of the fruit they soon progress to the more extensive green pulpy central area between the seeds leaving a black, liquid, digested material behind. This material eventually stains all or most of the skin of the fruit black as feeding progresses and all of the green pulp is devoured. The seeds remain undamaged but are imbedded in this digested material (Fig. 4) which hardens after the larva leaves the fruit for pupation. When the larvae are mature (Fig. 3) they are from 9-10 mm. in length, white and are located in the center near the base of the fruit. From this position they burrow outward usually laterally, cut a round hole in the skin of the fruit (Fig. 5) and drop to the ground for pupation.

Depending on the nature of the soil, the larvae dig down from

1-3 inches where they pupate without making a cell (Fig. 6). The pupal case is hard, can stand considerable pressure without being dented or damaged and the fly over-winters in this condition. The first three segments on the dorsal surface of the pupa are slightly depressed (Fig. 6) and have a lateral carina, evidently a weakened area, that curves inward in about the middle of the fourth segment. When the fly emerges this flap is pushed out, taking half of the fourth segment with it, and usually becomes detached from the rest of the pupa exposing the white silken inner lining (Fig. 7).

Between October 1 and 14, 1960, several hundred infested fruit of *S. elaeagnifolium* were brought into the laboratory for rearing purposes. The larvae were extracted from the fruit on October 14 and ranged in size from about half-grown to fully mature and ready for pupation. These were placed in glass jars with dirt in the bottom and kept between 70° and 75° F. All the larvae disappeared into the soil immediately and pupation occurred between October 15 and 17 at which time 38 of them were

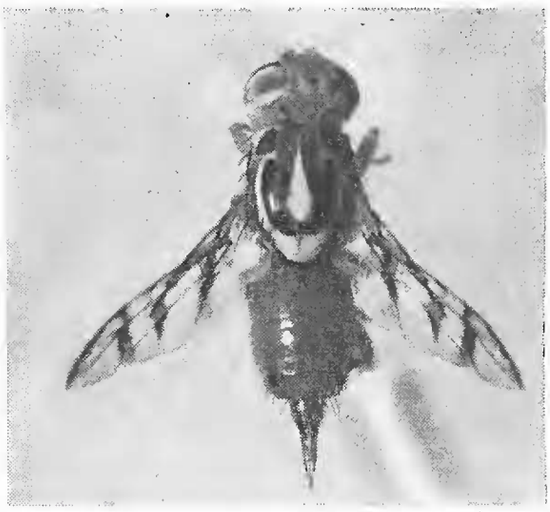

Fig. 1

Fig. 6

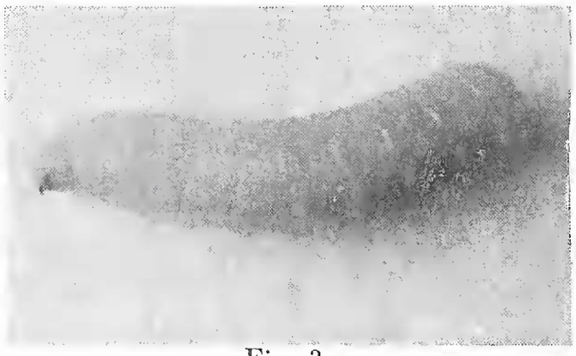

Fig. 3

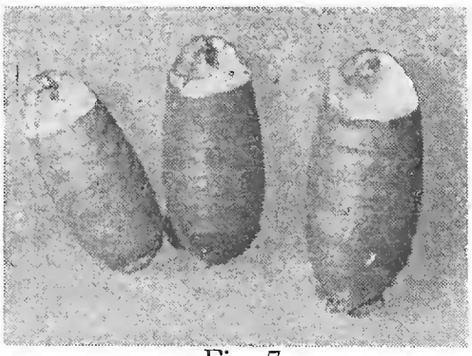

Fig. 7

EXPLANATION OF FIGURES

Zonosemata vittigera (Coquillett). Upper left, adult female; upper right, pupae; lower left, larva; lower right, pupae from which adults have emerged.

taken from the soil and placed in petri dishes for observation. Six pupae were placed in the climatizer and kept at temperatures ranging from 70-90° F. and at relative humidities ranging from 23-34% for varying periods of time. On December 7, 1960, one fly emerged in the laboratory and one in the climatizer and no further specimens emerged until May 19, 1961. This indicates considerable resistance or tolerance to changes in temperature and relative humidity and all but the two specimens withstood these abnormal conditions until May-August, their normal field emergence period.

Those larvae that pupated on October 15, 1960, emerged between June 6 and August 22, 1961, a minimum of 264 and maximum of 311 days and an average of 284 days in the pupal stage. Those pupated on October 25, 1960, emerged between June 26 and August 22, 1961, a minimum of 244, maximum of 278 and an average of 262 days. Those pupated on October 29, 1960, emerged on July 28, 1961, after 272 days in the pupal stage. One specimen that pupated on November 15, 1960, emerged on May 19, 1961, after 185 days as a pupa and four specimens that pupated on November 17, 1960, emerged on July 12 and 13, 1961, after 237 and 238 days as pupae. The range of the pupal period extended from 185-311 days with an average of 263 days. Since the emergence of the flies in the laboratory coincides closely with their appearance in the field it is probably that the above given figures would apply to specimens emerging under natural conditions at least in the area of the Chiricahua Mountains or under similar conditions.

While making field observations on *Zonosemata vittigera* a small (2-5 mm.) Braconid wasp with an orange-red body, black eyes, black legs, black antennae, fuscous wings and a black ovipositor which is almost as long as the body was seen flying around the *S. elaeagnifolium* plants or walking around on the stems, leaves and fruit. No females were observed inserting the ovipositor into the seed but the wasp, *Opius sanguineus* (Ashmead), (Fig. 8) is a larval parasite of both *Z. vittigera* and *Z. electa*. The female evidently uses the long ovipositor to insert her egg into the fly larva while it is still in the fruit. The fly larva isn't killed by the parasite until after pupation and the adult wasp emerges from the pupal case either by pushing the entire anterior end out or by chewing an irregular opening in it.

From *Z. vittigera* larvae that pupated in the laboratory on October 15, 1960, nine *Opius sanguineus* adults emerged between November 5 and 18, 1960, probably as a result of the high (70-75° F.) temperatures. Larvae that pupated on October 29, 1960,

Fig. 2

Fig. 5

Fig. 4

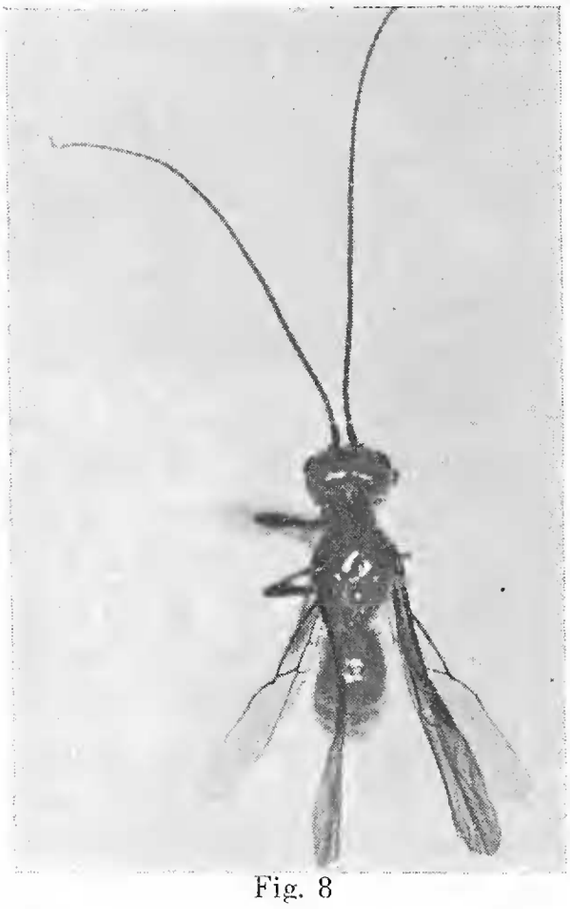

Fig. 8

EXPLANATION OF FIGURES

Upper left, green fruit of *Solanum elaeagnifolium* (Cavanilles) showing oviposition scars of *Zonosemata vittigera* (Coquillett); lower left, seeds imbedded in black waste material left by *Zonosemata* larva; upper right, emergence hole of *Zonosemata* adult; lower right, adult of *Opius sanguineus* (Ashmead).

gave rise to two adult *Opius* on September 16, 1961, or after 322 days from the pupation of the fly. Larvae that pupated on November 15, 1960, produced two *Opius* adults on August 21, 1961, or 279 days after the fly pupated. Since *Opius* oviposition was not observed it is impossible to give accurate figures on duration but the minimum indicated is 279 days, maximum 322 days and an average of 301 days that the wasp spends in the fly pupae.

ACKNOWLEDGMENTS

The author would like to express his appreciation to Mr. Wes Niles, University of Arizona, for the determination of the *Solanum*; Dr. R. H. Foote, Entomological Research Division, U.S.D.A., for the name of the *Zonosemata*; Dr. C. F. W. Muesebeck, Entomological Research Division, U.S.D.A., retired, for the determination of the *Opius* parasite. Special thanks are extended to Miss Marjorie Statham, Department of Entomology, American Museum of Natural History, New York, and Martin A. Mortenson, Southwestern Research Station, Portal, Arizona, for the excellent photographs.

LITERATURE CITED

FOOTE, R. H.
1960. Notes on some North American Tephritidae, with descriptions of two new genera and two new species. Proc. Biological Soc. Wash., 73:107-118.

KEARNEY, T. H. AND PEEBLES, R. H.
1951. Arizona Flora. University of California Press, Berkeley and Los Angeles.

OBSERVATIONS ON THE FLIGHT BEHAVIOR OF AN ASCALAPHID OF THE GENUS ULULODES

(Neuroptera: Ascalaphidae)

C. DON MACNEILL
California Academy of Sciences

The following notes are offered in the hope that they will be helpful to anyone attempting to work with the genus *Ululodes*. The few observations on behavior reported here, together with an awareness of the physical circumstances necessary to observe this behavior, might suggest the means for more effective sampling of populations and for detailed studies of behavior.

It was noticed that, in areas where these insects abound, they are readily observed or collected during a twenty-minute period commencing about one-half hour after sunset. During this period it is sufficiently dark that the low flying *Ululodes* are not visible